High Performance Computing:
Accelerating clean energy technology deployment

Julio Friedmann

Deputy Program Director, E&E Security
Lawrence Livermore National Laboratory

Secretary of Energy Advisory Board

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DOE leads the world in HPC application and use

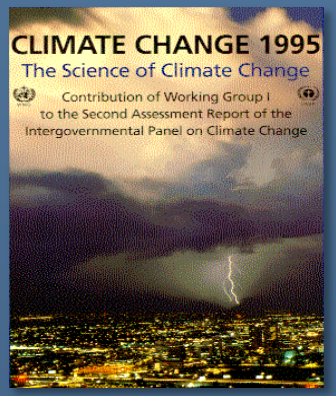
"…of all the sectors in the economy where innovation has a critical role to play, the energy sector stands out."

American Energy Innovation Council
September 2011

- ASC
- SciDAC
- New applied programs
  - Nuclear
  - Fossil

Opportunity to leverage to experience and investment
to accelerate clean energy development and commercialization

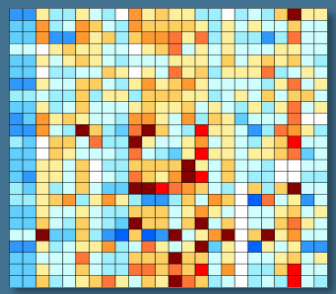
World leader in climate change detection and attribution

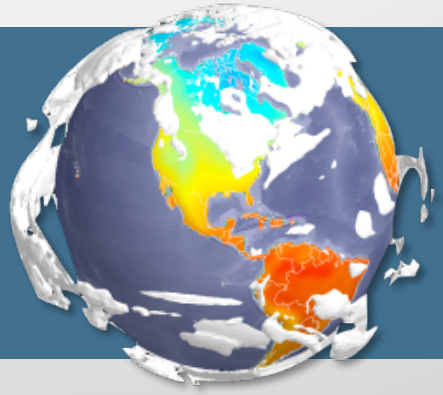


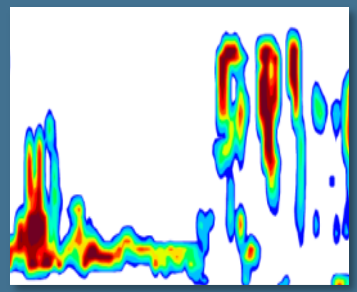
"The balance of evidence suggests a discernible human influence on global climate."

- Ben Santer

DOE/SC Program on Climate Model, Diagnosis and Intercomparison at LLNL has played a key role in the international climate community





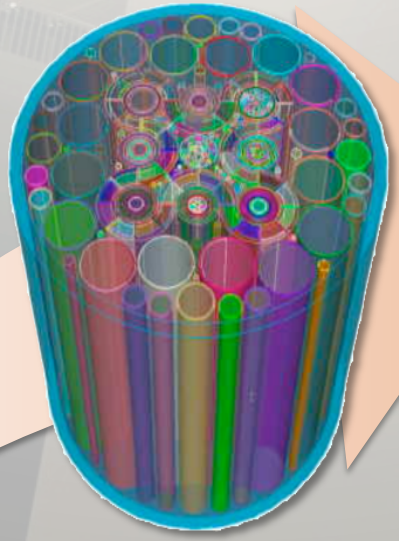


- Goal: Quantify fidelity of model simulations and uncertainty in projections
- Research:
  - Understand fidelity of climate model simulations
  - Diagnose and fingerprint human signatures in climate change
- Publications: 186 peer review publications from DOE funding over the last seven years with 21 in Science, Nature and PNAS

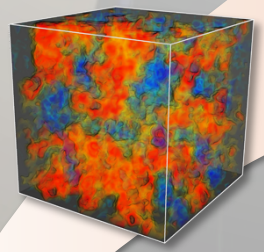
Made possible by HPC platforms, expertise, and ecosystem

A key element of our energy and climate strategy revolves around the application of HPC and simulation

Applied energy simulations



Basic science and algorithms



Platform and architectural development

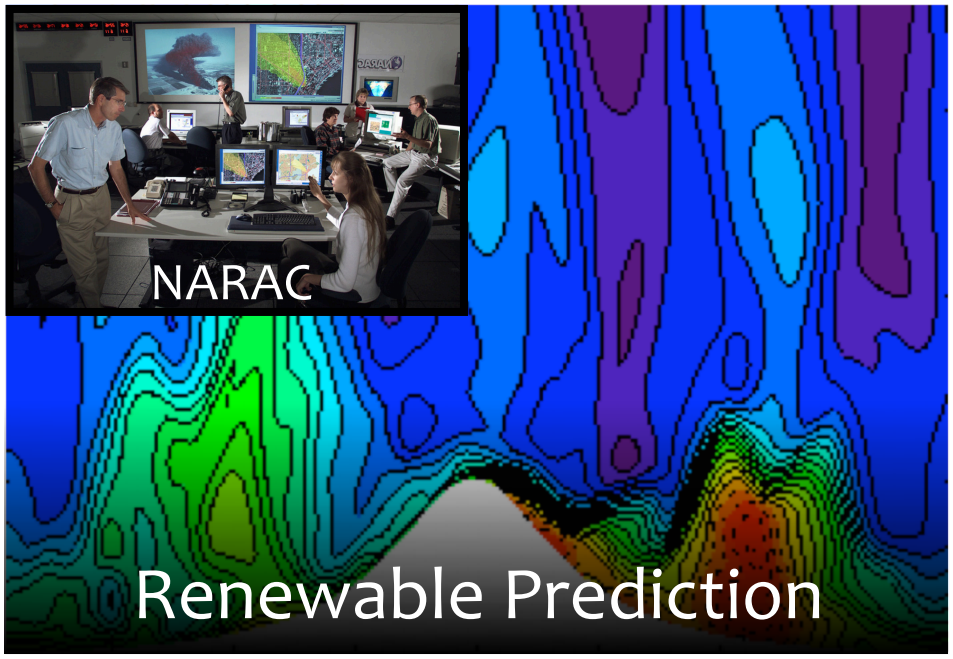
Path to exascale computing

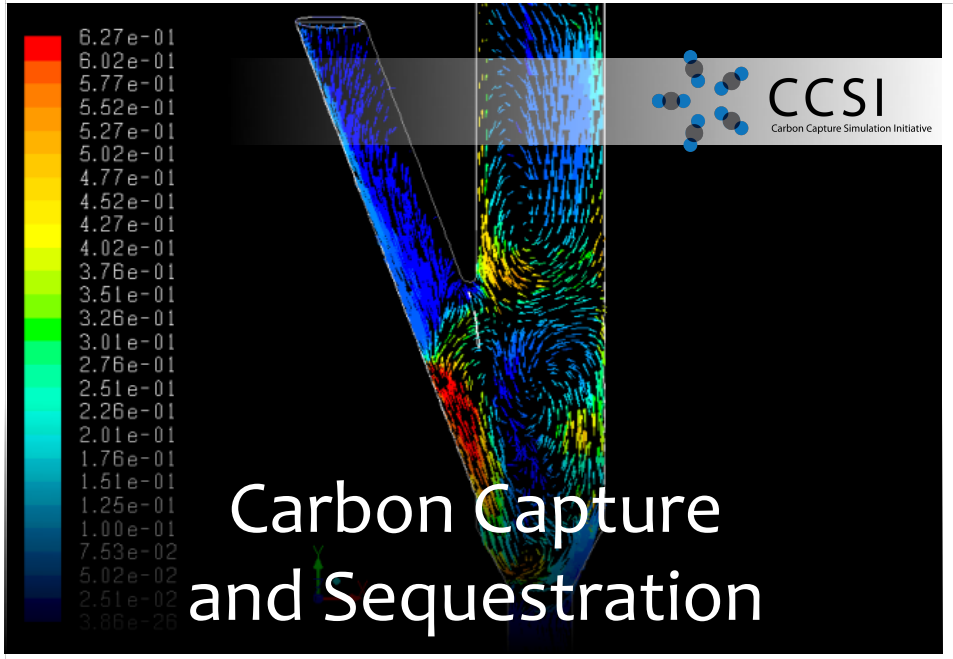
- Building efficiency
- Carbon Capture and Storage
- Smart grid and integration
- Fusion design
- Uncertainty Quantification for Climate

We are creating new partnerships with America's private sector to accelerate the development and commercialization of advanced, clean energy technology


Efficient Buildings


NAVISTAR
AERODYNAMICS
ENERGY
Lawrence Livermore National Laboratory
Efficient Vehicles


NARAC
Renewable Prediction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1.76e-01
1.51e-01
1.25e-01
1.00e-01
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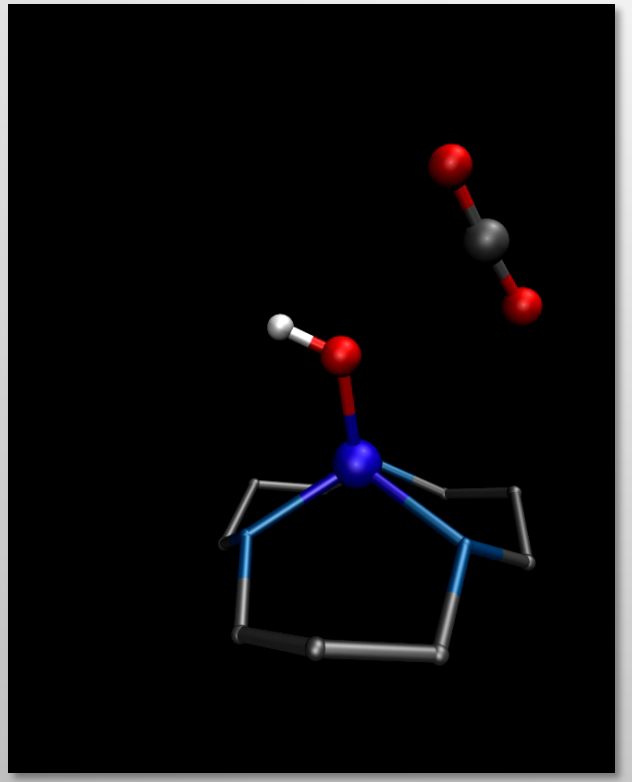
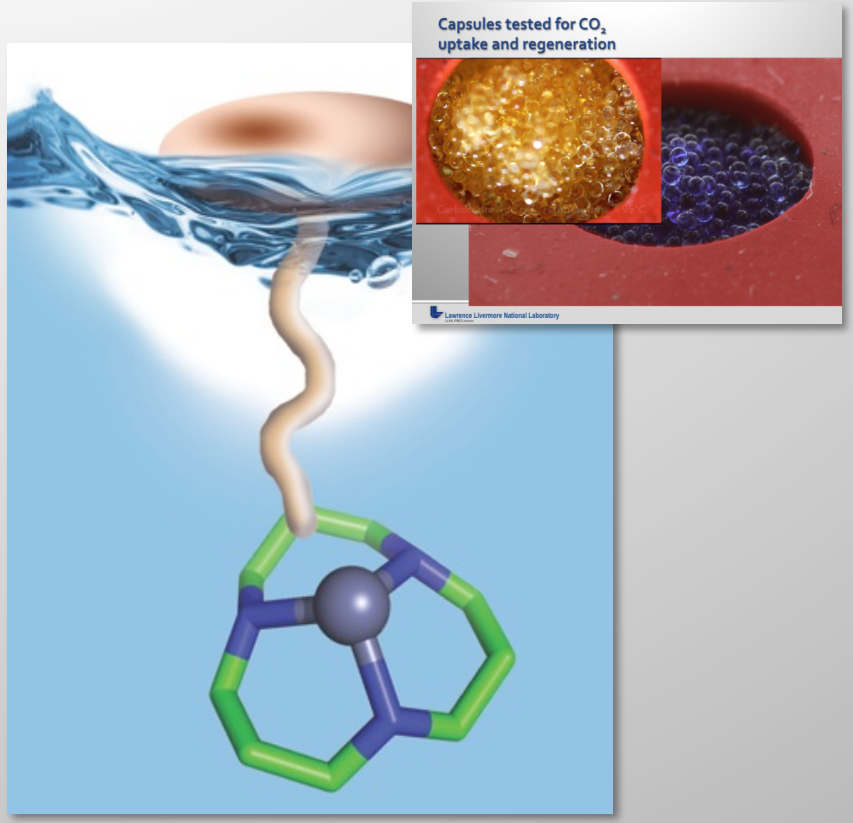
3.86e-26
CCSI
Carbon Capture Simulation Initiative
Carbon Capture and Sequestration

HPC has proven successful in molecular dynamics and design to make materials for clean energy





Potential Applications

- Carbon Capture
- Biofuels
- Storage
- Solar

CA Energy Systems for 21st Century (CES-21) is a new $150M, five-year partnership to speed smart grid solutions

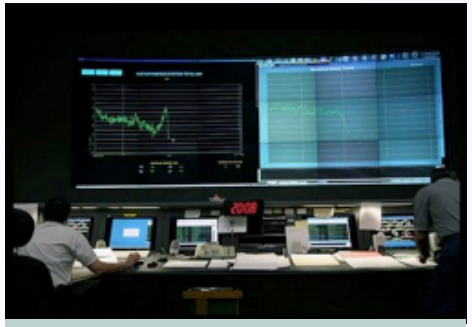
Investor-Owned Utilities (IOUs)

Experts in power generation, transmission, cyber security, and distribution

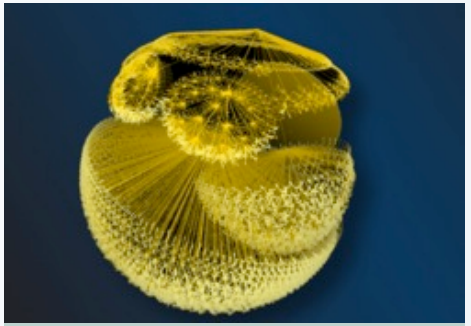
Lawrence Livermore National Laboratory

Experts in solving complex problems with modeling and simulation, science-based decision support, and broad technology development and engineering

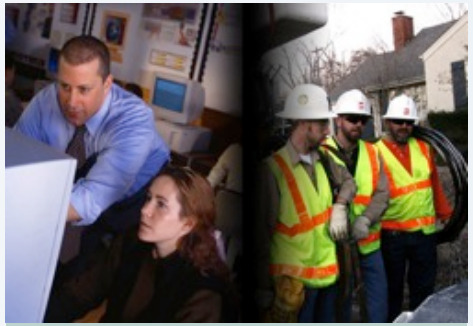
Planning



Operations



Security



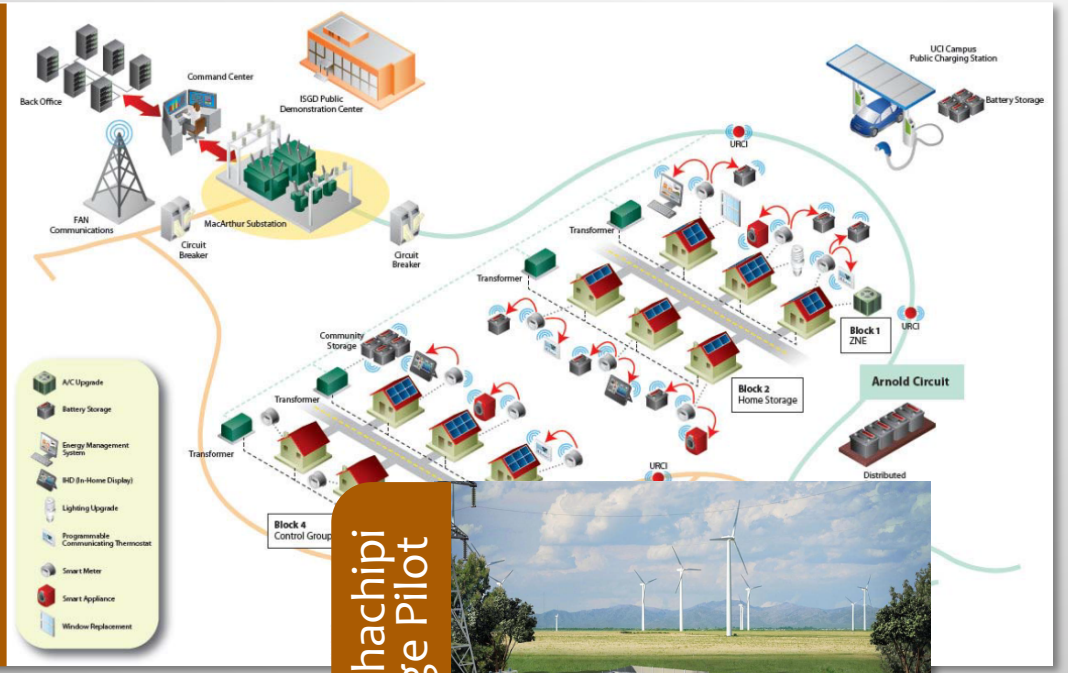
Workforce

CES-21 status

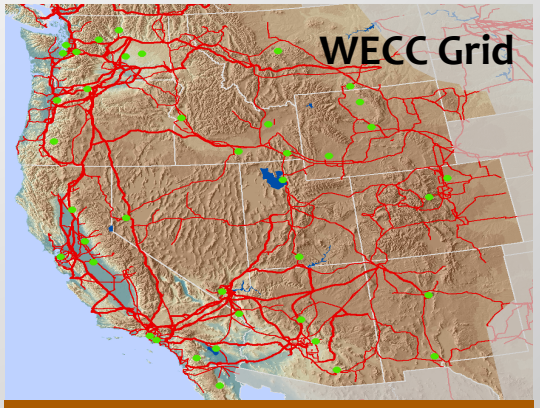
- Application to CPUC was filed July 18
- Approval anticipated spring 2012
- Related work for PG&E and CEC has started

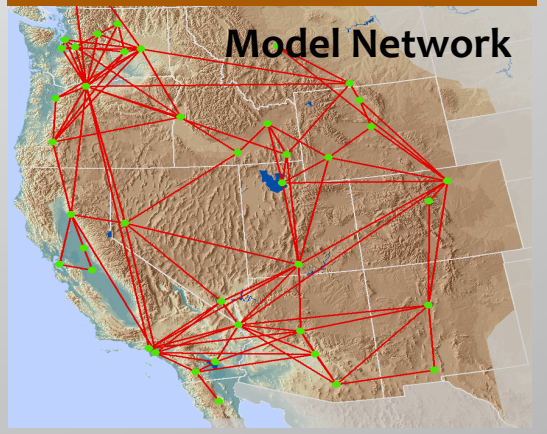
HPC is ideally suited for scale-up of grid models and pilot projects

SCE Irvine Smart Grid Pilot



SCE Tehachipi Storage Pilot





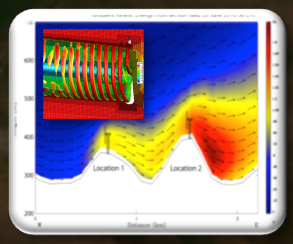
16 homes to 16 million homes in California to 160 million homes nationwide
One 32 MW-h storage project to >10,000 nodes; differing wind energy domains

Site 300 provides a world-class clean-power R&D field lab and test facility

Site 300

Research agenda in development

- High-res observations + generation/ connectivity
- Renewable integration and leveling
- Storage testing
- Clean-tech prediction, validation, comparison
- Defense energy platform testing

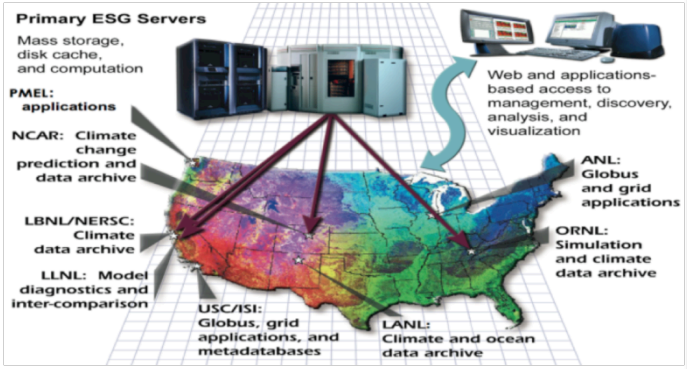


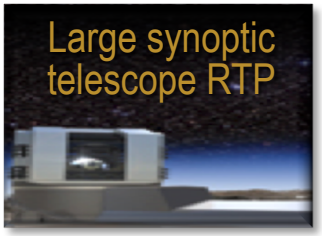


Data-centric and high-throughput computing can reduce cost, risk, and waste

LLNL capabilities and existing programs

Earth Systems Grid

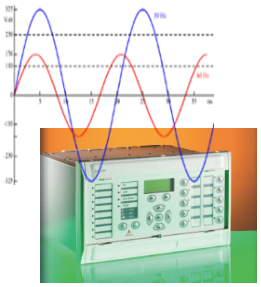




Applications to smart grid management

Smart Meter

PMU



Estimated cost of San Diego power outage: $97-118M
Estimate wasted energy from lack of information and processing: 3 trillion kW-hr
Estimated data volume from CA smart meters in 2015: 100 Tbytes/month

Livermore Valley Open Campus and HPC-IC will anchor transformational new partnerships (LLNL and SNL)


HPC Innovation Center
Dedication May 2011

DOE leadership led to National Summit and near term actions

DOE Workshop on HPC and Energy

- Led by Steve Koonin (October 2010)
- Engaged 13 lab directors, key CEOs (e.g., IBM)
- Tasked LLNL to spearhead effort

National Summit: Washington, May 2011

- Organized by Howard baker Forum, Bipartisan Policy Commission, and LLNL
- Keynotes: Holdren, Gen. Jones, Koonin, Dorgan, Hoeven: IBM, Siemens; LLNL, ORNL, ANL, RPI
- Five topics: Smart-grid; CCUS; Combustion; Efficient Buildings; Nuclear

Immediate actions recommended

- Call for proposals for HPC time to business
- Co-sponsor meetings
- Integrated web portal

Report on

A NATIONAL SUMMIT ON ADVANCING CLEAN ENERGY TECHNOLOGIES

Entrepreneurship and Innovation through High Performance Computing

John Holdren

Steve Koonin

Other countries are linking HPC to national competiveness


CAS Supercomputer Center

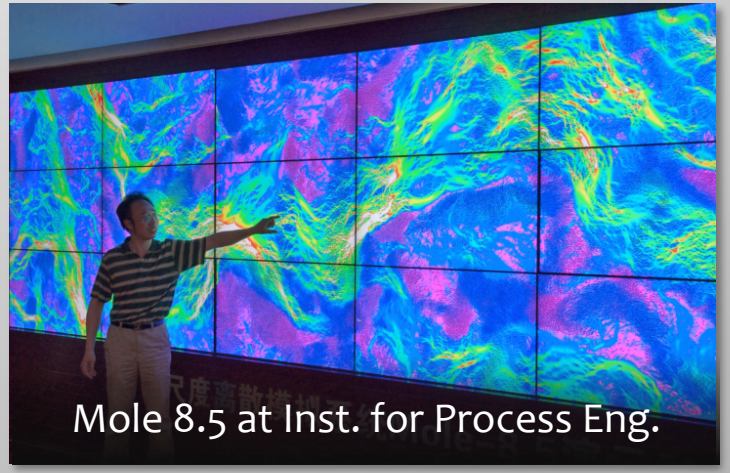
Top 500 Systems in China

#2 (Tianhe-1A), Tianjin

#4 (Dawning Nebulae), Shenzhen

#33 (Mole 8.5), CAS-IPE, Beijing

#40 (Magic Cube), Shanghai


Mole 8.5 at Inst. for Process Eng.

US competitiveness and clean energy economy hang in the balance